

Chiller Water System Optimization

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COST - Total Cost of Ownership

Plan & Spec focus

Visible
Costs

Price/Time

Energy Costs

Engineering Charges Equipment Shutdown Costs

Maintenance Costs Legal Costs

Construction Change Orders

System Performance Problems

Start-up Delays

Distribution Piping

Hidden
Costs

Owner's Costs

Innovation → Efficiency → Savings = *Guaranteed*

Challenges with traditional Plan & Spec Approach

- ♦ **Disparity of Metrics (Economic Drivers) between Design/Construction and Operations/Maintenance**
- ♦ **Very slow to drive innovative solutions into the market**
- ♦ **Little overall understanding of Life-Cycle economics of systems**
- ♦ **Innovation is not rewarded**

Solution—Develop Performance Based Specifications & Measurements

- ♦ **Accurately Measure Real-Time KW/Ton**
- ♦ **Determine the Life-Cycle Value of a KW**
- ♦ **Require Liquidated Damages for underperformance relative to Life-Cycle Cost**
- ♦ **Require Performance Monitoring to Maintain Future Plant Performance**
- ♦ **Align Owner Value with Supplier Value (Bonus/Penalty based on Performance)**
- ♦ **Other Measurements—Schedule, Change-Orders, Quality, Reliability, Maintenance Cost**

Innovation → Efficiency → Savings = ^{Guaranteed} Optimal Solution

Packaged central plants **A PARADIGM SHIFT**

Field
Erected
Central
Plant



Did you know
that chillers are
typically only
20% of the cost
of a field
erected plant
installation?

Labor
comprises 35-
40% of costs!

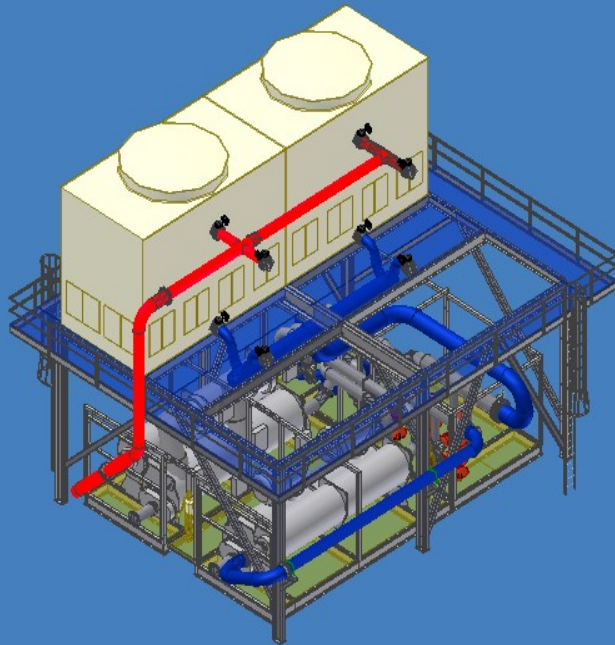


TAS Packaged
Central Plant

greater efficiency and lower operating (energy) costs--

Guaranteed

Technology used to Improve System Performance



- ✓ Engineered System Package:
 - Complete Chilled Water Plant
 - Highly Engineered
 - Optimized Designs
 - Measured Performance
 - Focus on Owner Economics

- ✓ Guaranteed:
 - Cost (\$/ton)
 - System Efficiency (KW/ton)
 - Completion date (Months)

Innovation → Efficiency → Savings = *Guaranteed* Optimal Solution



Performance Standard

- ✓ Efficiency
- ✓ First Cost
- ✓ Constructability
- ✓ Reliability
- ✓ Maintainability
- ✓ ISO 9001:2000
- ✓ Installation Safety
- ✓ Portability
- ✓ Global Service
- ✓ Aesthetics



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Army Corps of Engineers Bulletin



US Army Corps
of Engineers

ENGINEERING AND CONSTRUCTION BULLETIN

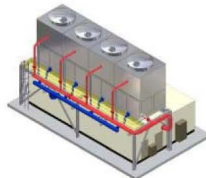
No. 2004-16 Issuing Office: CECW-CE-D Issued: 17 Sept 2004 Expires: 17 Sept 2006

Subject: Packaged Chilled Water Plants

Applicability: Information

1. **Introduction.** Complete pre-engineered, factory-built chilled water plants are a proven alternative to traditional site-built facilities. Packaged chiller plants generally include factory-installed chillers, all chilled and condenser water pumps, controls, single-point electrical connection (transformers, MCCs, starters, air conditioning, emergency lighting, etc.). Also included is a seismic, wind, snow-designed enclosure, the cooling tower components (interconnecting piping, platform, ladders, etc.), and all related equipment to provide a complete chilled water system.

2. **Background.** Packaging of industrial equipment has been an evolving trend for many years. Packaging of complete chilled water plants has been occurring since the late 1990s. Packaged plants have been installed on five continents, have more than 150 installations, and have in excess of 300,000 tons of installed capacity. Packages generally are configured in 400 ton to 8,000 ton single modules and can be combined in any number of ways. Centrifugal, screw, or absorption chilling technologies (along with water or air cooled heat rejection) can be selected to support any chilled water requirement or site limitation. Towers may be installed over, adjacent, or remote to the central plant.



**Schematic of Typical Water Cooled
Packaged Chilled Water Plant**

3. **Benefits.** There are numerous benefits identified with a packaged plant approach as discussed below.

a. **Reduced Installed Cost.** Packaged central plants have proven to generally be a lower capital cost solution. Savings are generally between 20% and 40% versus a field-erected chiller plant.

ECB 2004-16

Subject: Packaged Chilled Water Plants

b. **Shortened Project Schedule.** A packaged central plant can generally be placed into operation in approximately 24 weeks from date of award. Actual site construction of a packaged plant is typically less than 8 weeks. Site-built plants generally require more than 1 year until they are producing chilled water.

c. **Guaranteed System Efficiency.** Packaged chilled water plants are normally procured with a Total System Efficiency Guarantee. The ability to control energy costs at the plant level is a significant benefit compared with traditional plants where energy optimization is attempted at the component level. The packager of the chiller plant has the opportunity to optimize the overall system through comparisons of chillers, pumps and heat rejection loads in order to develop its particular design. Previous installations have demonstrated electrical power savings of approximately 30% compared with similar site-built plants.

d. **Portability.** While chiller plants generally remain in one location, the packaged plant offers the flexibility of redeployment. Also, it allows for easy additions of modular plants to increase capacity. The flexibility of a packaged plant is ideal for locations that may grow, have short-term needs, or will be reconfigured in the future.



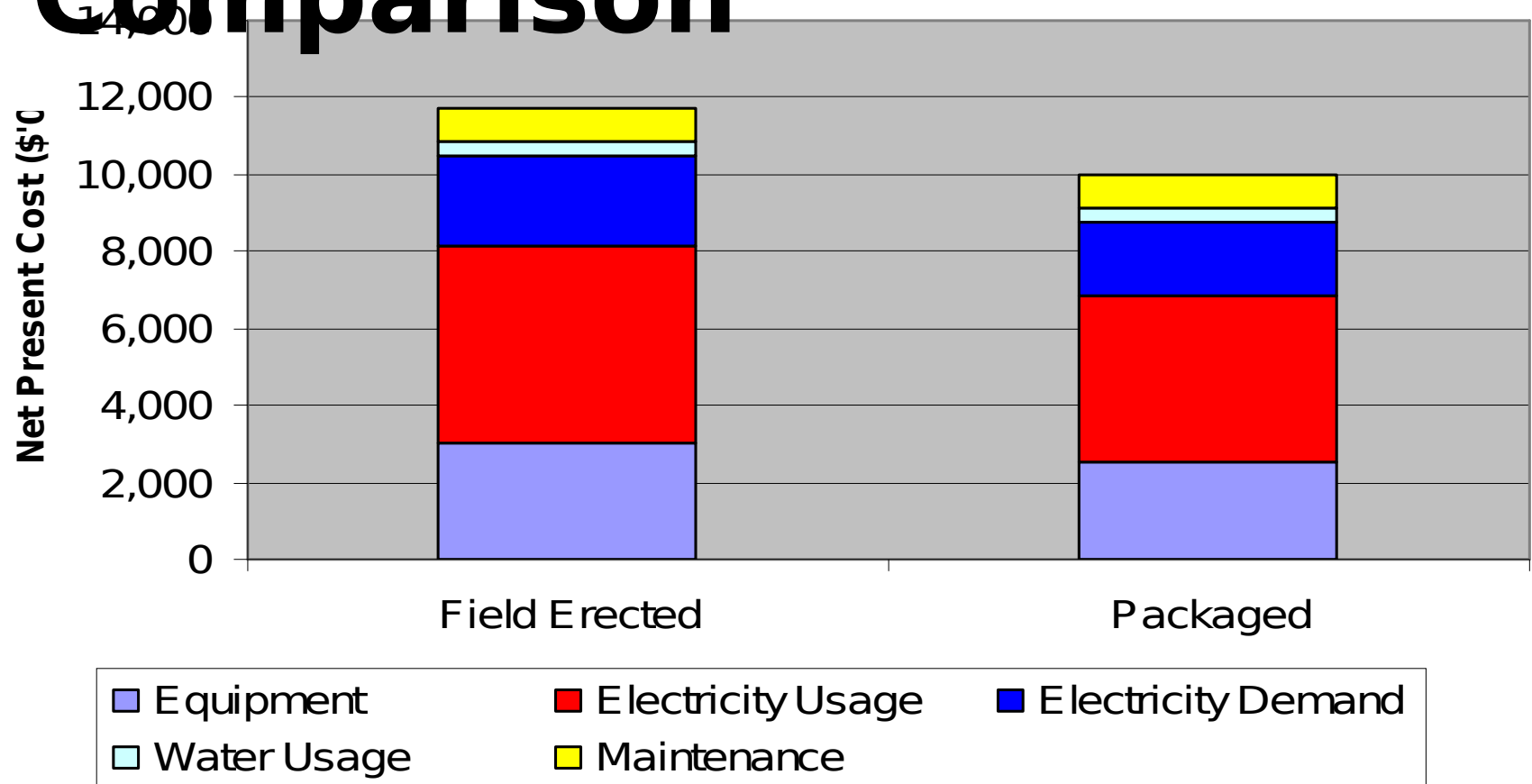
**2,000 Ton Air-Cooled Packaged
Plant Being Off-Loaded at
Baghdad Airport, Iraq**

e. **Reduced Site Risk.** Moving the majority of manufacturing of a chiller plant from the project site to a controlled factory environment reduces overall risk. Cost, time and safety all benefit from controlling weather, labor supply and quality, quality control and quality assurance processes, and material availability.

f. **Simplified Architectural Planning & Budgeting.** Utilizing a "standard" product provides for immediate availability of general arrangement and related site planning tools. Quick and inexpensive site conceptualization provides better project planning and budgeting. Additionally, large chilled water loop locations can benefit by locating multiple packaged plants near the loads, rather than having to settle for one large central plant. The package plant comes with a full structural support base and uses a standard reinforced concrete pad, thereby eliminating the need for a heavily engineered structural base.

g. **Reduced Footprint.** The compact design of a packaged plant generally affords a dramatically smaller footprint compared to traditional designs. The equipment enclosures enable

Net Present Cost Comparison



Innovation → Efficiency → Savings → Optimal Solution

Greater Efficiency Means... **LOWER OPERATING COSTS**



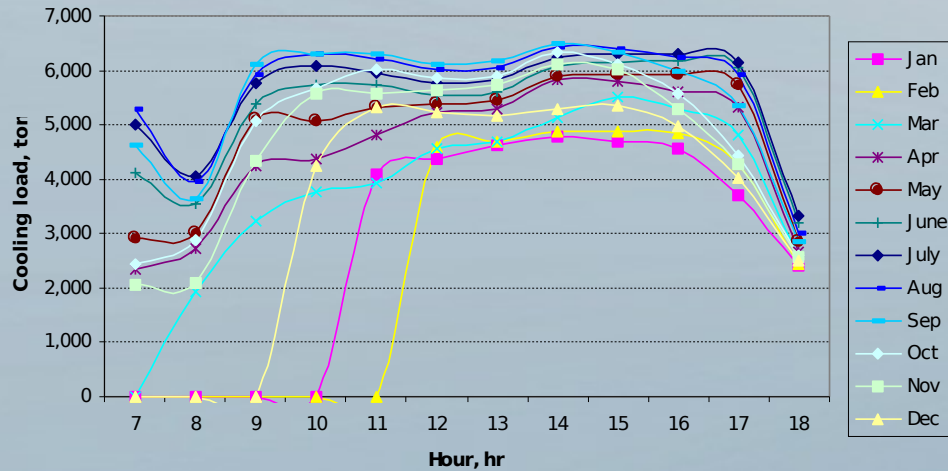
Total plant efficiency can be measured with a TAS packaged central plant – with field erected it usually isn't.

characteristically 10% to 20% more efficient operation; comparable energy savings

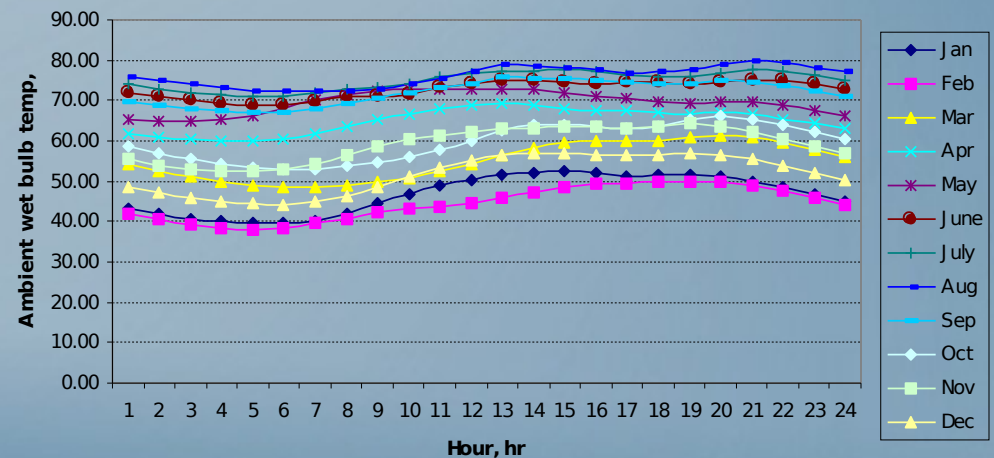
Innovation → Efficiency → Savings → *Guaranteed* Optimal Solution

CASE STUDY - Load Profile and Ambient Wet Bulb Temp

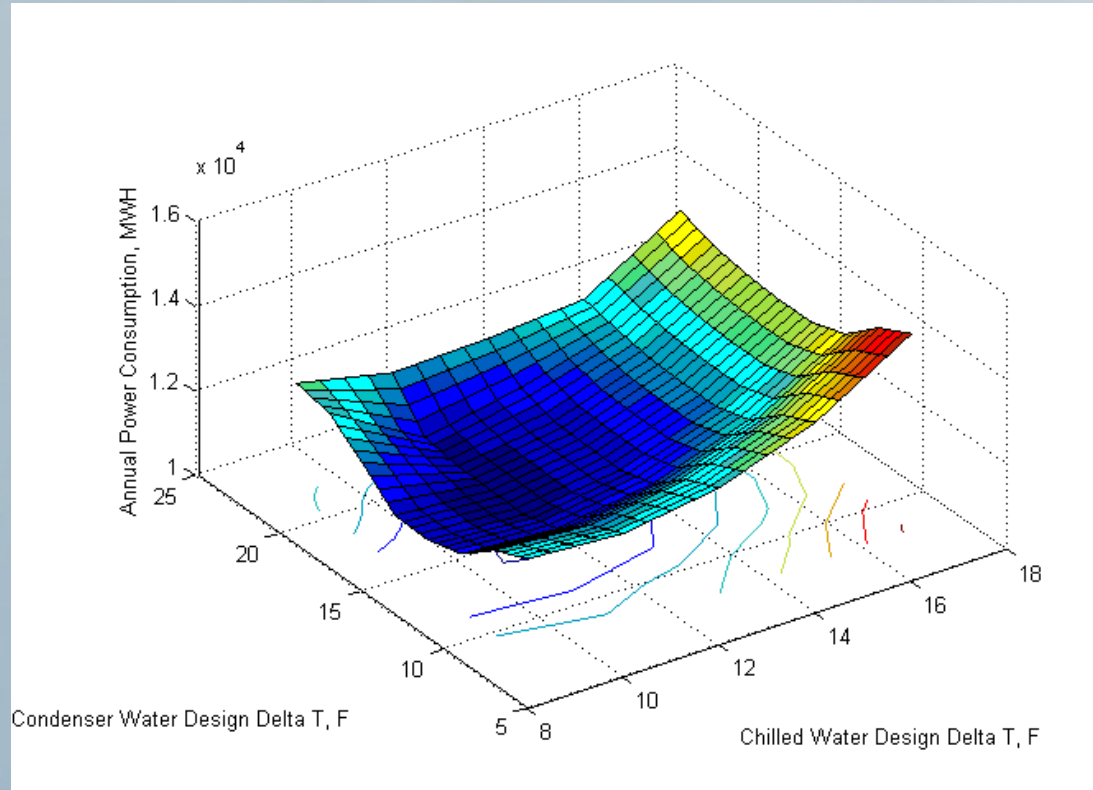
Load Characteristics



Ambient Wet Bulb Temp



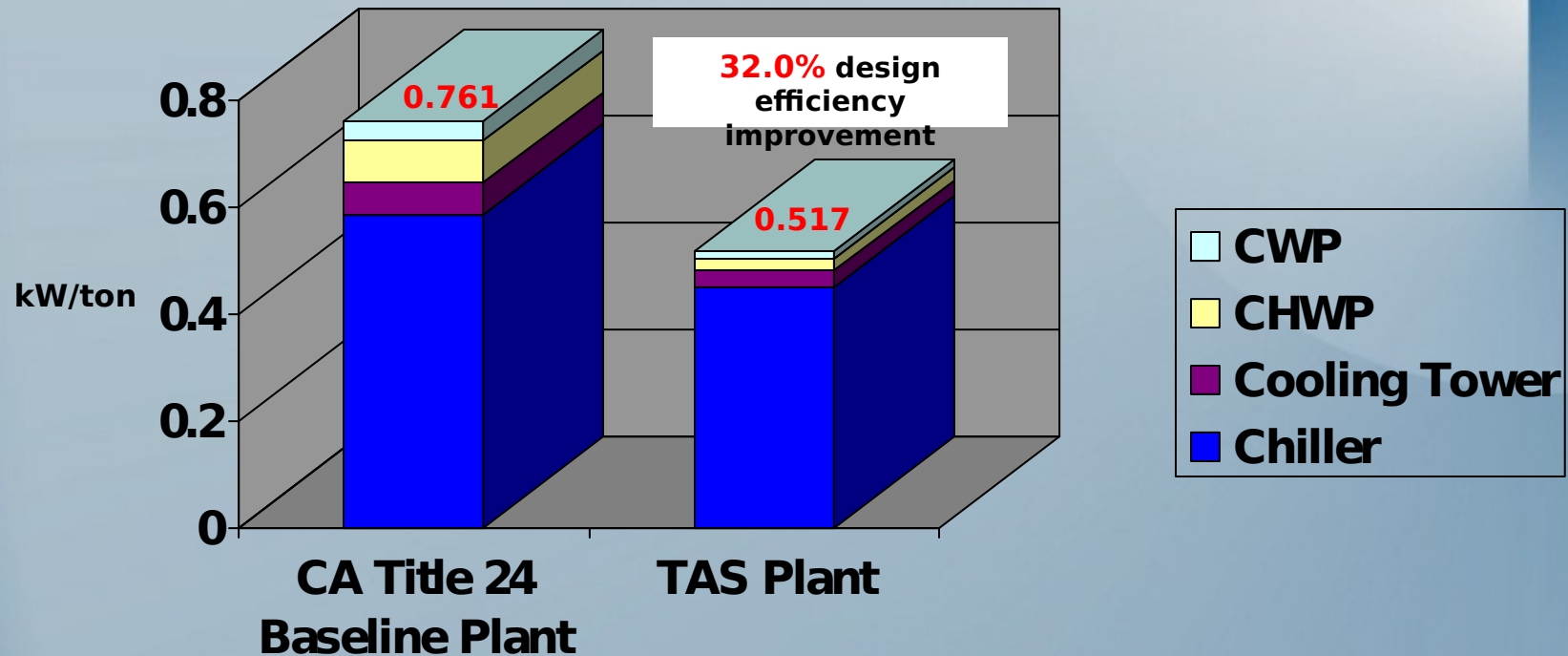
CASE STUDY - Impact of condenser/chilled water design delta T



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TAS PLANT VS. TITLE 24 BASELINE PLANT

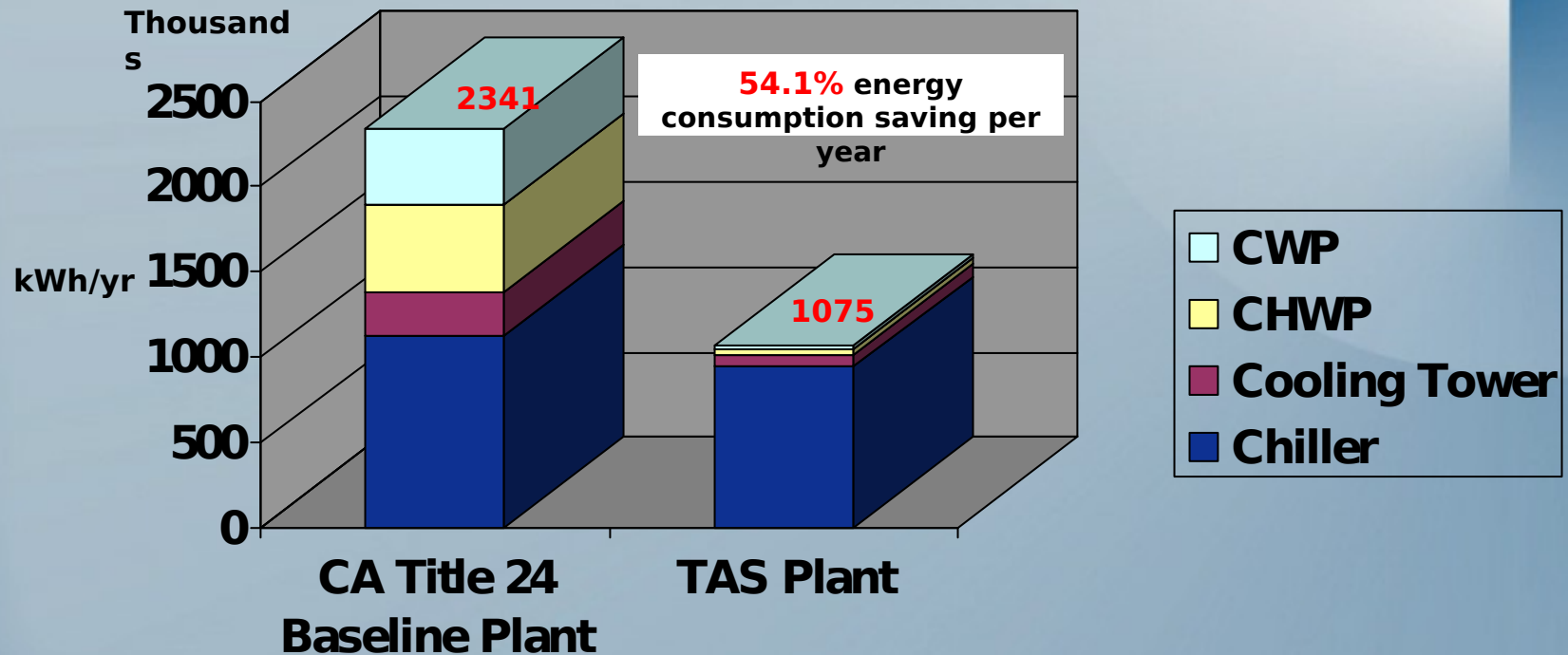
Design Efficiency (1500 tons plant, Los Angeles, CA)



TAS Chilled Water Plant vs. Title 24 Baseline

TAS PLANT VS. TITLE 24 BASELINE PLANT

Annual Electricity Consumption (1500 tons plant, Los Angeles, CA)



TAS Chilled Water Plant vs. Title 24 Baseline

TAS PLANT VS. TITLE 24 BASELINE PLANT - How its Done

DESIGN	CA Title 24		Efficient Design by running TAS-OPT	
	KW/ton	Description	KW/ton	Description
Chiller	0.585	Low- efficiency: high lift, low Delta T design	0.45	Centrifugal/Screw water-cooled, low lift, High Delta T design
Cooling Tower	0.059	Oversized cooling tower, low temp range	0.030	Extra fill area design, High temp range
Chilled Water Pump	0.079	Oversized pump, 2.4 gpm/ton (ARI design condition)	0.024	1.34 gpm/ton
Condenser Water Pump	0.038	Oversized pump, 3.0 gpm/ton (ARI design condition)	0.013	1.96 gpm/ton
TOTAL	0.761		0.517	32.0% improvement in system design efficiency

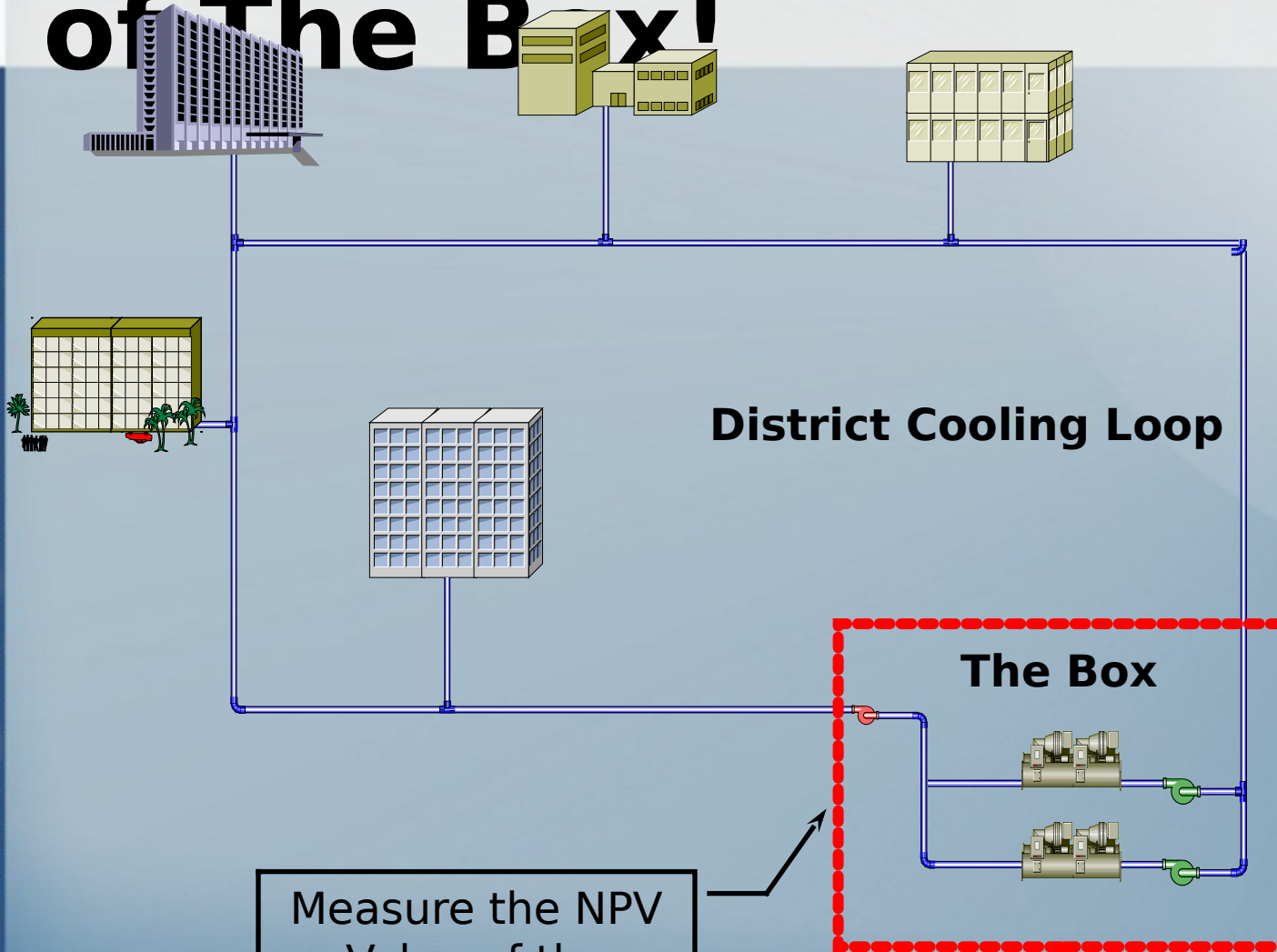
OPERATION	CA Title 24		Efficient Operation	
	10 ³ kWh/yr	Description	10 ³ kWh/yr	Description
Chiller	1126.2	Fixed chilled water temp setpoint	942.1	Demand Response Control, Chilled Water Temp Reset, Modernize chiller control
Cooling Tower	255.2	Fixed condenser water temp setpoint	76.2	Chiller-Tower optimal control, Cooling water temp reset, VFD fan control
Chilled Water Pump	511.8	Constant speed pump	29.9	Variable flow control
Condenser Water Pump	447.9	Constant speed pump	27.0	Variable flow control
TOTAL	2341.1		1075.2	54.1% annual energy saving

The Packaged Comparison

Compared to traditional field erected chilling plants....

☒ Efficiency	Typically 20-30% more efficient
☒ First Cost	15 - 20% initial savings
☒ Constructability	30 - 40% savings in schedule
☒ Reliability	Fully tested premium components
☒ Maintainability	10 - 15% O&M cost savings
☒ ISO 9001:2000	Continual & rigorous quality process
☒ Installation Safety	50% less site construction time
☒ Flexibility	Moveable and easy to expand or upgrade
☒ Retrofit Compatible	Can be installed without interrupting bldg operations—tie in done over the weekend
☒ Remote	Can easily be monitored remotely for

CONCLUSION - Think Out of The Box!



Measure the NPV
Value of the
Entire Chiller

Plant

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Guaranteed